

Use of Computer Based Training for Aircraft Inspectors: Findings and Recommendations

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ABSTRACT

Research in aircraft inspection and maintenance has revealed the criticality of human inspection performance in improving aviation safety. Training has been identified as the primary intervention strategy in improving the quality and reliability of aircraft inspection performance. If training is to be successful, it is clear that we need to provide aircraft inspectors with tools to help enhance their inspection skills and improve performance. In response to this need, the Clemson research team developed a high fidelity inspection-training simulator (ASSIST: Automated System of Self Instruction for Specialized Training) – a specialized inspection software focused on improving aircraft inspection performance. Following the development a detailed usability evaluation was conducted and is reported as a part of this paper.

INTRODUCTION

Training has been identified as the primary intervention strategy in improving inspection performance. If training is to be successful, it is clear that we need to provide inspectors with training tools to help enhance their inspection skills. Existing training for inspectors in the aircraft maintenance environment tends to be mostly on-the-job training (OJT). Nevertheless, this may not be the best method of instruction (FAA, 1991; Gordon, 1994). For example, in OJT feedback may be infrequent, unmethodical, and/or delayed. Moreover, in certain instances feedback is economically prohibitive or infeasible due to the nature of the task. Thus, because the benefits of feedback in training have been well documented (e.g. Weiner, 1975), and for other reasons as well, alternatives to OJT are sought.

In response to this need, this paper describes the findings of implementing a computer based inspection training system, entitled ASSIST (Automated System of Self Instruction for Specialized Training), for aircraft inspection training. Specifically the paper describes the results of usability studies that focused on evaluating ASSIST in the aircraft maintenance environment. Thus, off-line training/retraining with feedback has a role to play in aircraft inspection training.

ASSIST SYSTEM DESCRIPTION

ASSIST consists of three major modules: (1) General Inspection module, (2) Inspection Simulation Training module, and (3) Instructor's Utilities module. All system users interact through a user-friendly interface. The user interface capitalizes on graphical user interface technologies and human

factors research on information presentation (e.g. color, formatting, layout, etc.), ease of use and information utilization.

ASSIST System Specification

The ASSIST program runs on at least a Pentium 100, with a 166 Pentium or greater suggested. A minimum hard drive space of 220 MB is required with at least 24 MB of memory, while 64 MB is the suggested memory. ASSIST runs on a Windows 95, or higher, operating system. The program also requires a SoundBlaster compatible sound card and 8X CD-ROM. The display requirements are 640 X 480 resolution with a high color (16 bit) palette. The program uses text, graphics and audio. The system's input devices are a keyboard and a mouse.

General Module

The objective of the general module is to provide the inspectors with an overview on the following topics: (1) role of the inspector, (2) safety, (3) aircraft review, (4) factors affecting inspection, and (5) inspection procedure. Each of these topics was made into a sub-module in the General Module. The module is based on presenting information through various media of text, pictures, audio, and video. At the end of each sub-module is a three-question quiz to reinforce the information learned. Development of the General Module was an iterative process involving regular feedback from industry partners on the content of each sub-module.

Instructor's Utilities Module

This module allows the instructor to access the results of the final test in the general module and the simulator along with having a utility to setup parameters for a simulation (Figure 12). The module is designed as a separate stand-alone tool that is linked to the other modules of the system. The instructor's module allows the instructors to review the performance of a trainee who has taken several training and/or testing sessions. Performance data from the simulator is stored on an individual image basis and summarized over the entire session so that results can be retrieved at either level. The utility allows the instructor to print or save the results to a file. The objective of this functionality is to provide the instructor with a utility where a specific image along with its associated information can be viewed on the computer screen.

Inspection Simulation Training Module

This module of the training program provides inspection training on a simulated aircraft inspection task (Aft Cargo Bin inspection of a Lockheed Martin L-1011. By manipulating the various task complexity factors (shape of viewing area, spatial distribution of faults, fault probability, fault mix, fault conspicuity, product complexity, and fault standards) the instructor can simulate different inspection scenarios. The simulation module uses actual photographs of the airframe structure with computer-generated defects.

FINDINGS AND RECOMMENDATIONS

Usability Analysis Results

To test whether the ASSIST software met usability goals, inspectors, supervisors, and mechanics at aircraft maintenance facilities evaluated the software on specific usability dimensions (e.g., content, presentation, and format). A separate usability questionnaire was administered for the general and the simulation modules. The questionnaire for the General Module and the Simulation Module are shown in Figures 1-6. Similar questions were asked about the Simulation Module.

The Cronbach's Alpha Coefficient was calculated for content, presentation, and format. These results are shown in Table 1. The coefficients for each category of questions were within the prescribed limits (0.6 and 1.0) therefore it was appropriate to group the questions together in to their respective dimension. The preliminary results of the usability survey are summarized in Table 2, listing the mean and standard deviation for each usability dimension. A Wilcoxon signed rank test was used to compare whether the subjects preferred the system of each of the three different usability dimensions. The test compared the actual mean scores versus the expected mean score (of 4.0). The results revealed that the subjects favored the computer system on all the dimensions investigated (refer to Table 3).

Content (Excerpt from General Module Questionnaire)						
1. The amount of information presented was adequate.						
1	2	3	4	5	6	7
Very Strongly Agree			Neutral			Very Strongly Disagree
2. The information presented is extremely relevant to my job as an inspector.						
1	2	3	4	5	6	7
Very Strongly Agree			Neutral		Disagree	Very Strongly Disagree
3. The subjects were well covered.						
1	2	3	4	5	6	7
Very Strongly Agree			Neutral			Very Strongly Disagree

Figure 1: Content Section from General Module

Presentation (Excerpt from General Module Questionnaire)						
1. The language used by the speaker was understandable.						
1	2	3	4	5	6	7
Very Strongly Disagree			Neutral			Very Strongly Agree
2. The screens were understandable.						
1	2	3	4	5	6	7
Very Strongly Disagree			Neutral			Very Strongly Agree
3. The information presented flowed smoothly.						
1	2	3	4	5	6	7
Very Strongly Disagree			Neutral			Very Strongly Agree
4. The presentation was interesting.						
1	2	3	4	5	6	7
Very Strongly Disagree			Neutral			Very Strongly Agree
5. The narration in the modules helped in understanding the material						
1	2	3	4	5	6	7
Very Strongly Disagree			Neutral			Very Strongly Agree
6. It was easy to navigate through the modules.						
1	2	3	4	5	6	7
Very Strongly Disagree			Neutral			Very Strongly Agree

Figure 2: Presentation Section from General Module

Format (Excerpt from General Module Questionnaire)						
1. The colors used on the screen did not distract from the task or cause eye discomfort.						
1	2	3	4	5	6	7
Very Strongly Disagree			Neutral			Very Strongly Agree
2. The buttons on the screen were easy to understand.						
1	2	3	4	5	6	7
Very Strongly Disagree			Neutral			Very Strongly Agree

Format (cont.-Excerpt from General Module Questionnaire)

3. The time for the computer to process information did not frustrate you.

1	2	3	4	5	6	7
Very			Neutral			Very
Strongly						Strongly
Disagree						Agree

4. You were satisfied with the interaction with the computer.

1	2	3	4	5	6	7
Very			Neutral			Very
Strongly						Strongly
Disagree						Agree

5. The tutorial was effective in providing instruction.

1	2	3	4	5	6	7
Very			Neutral			Very
Strongly						Strongly
Disagree						Agree

6. The colors used were pleasing.

1	2	3	4	5	6	7
Very			Neutral			Very
Strongly						Strongly
Disagree						Agree

Figure 3: Format Section from General Module

Content (Excerpt from Simulation Module Questionnaire)

1. The amount of information presented was adequate.

1	2	3	4	5	6	7
Very			Neutral			Very
Strongly						Strongly
Disagree						Agree

2. The subjects were thoroughly covered.

1	2	3	4	5	6	7
Very			Neutral			Very
Strongly						Strongly
Disagree						Agree

3. The information presented was understandable.

1	2	3	4	5	6	7
Very			Neutral			Very
Strongly						Strongly
Disagree						Agree

Figure 4: Content Section from Simulation Module

Presentation (Excerpt from Simulation Module Questionnaire)

1. The language used by the speaker was understandable.

1	2	3	4	5	6	7
Very			Neutral			Very
Strongly						Strongly
Disagree						Agree

2. The screens were understandable.

1	2	3	4	5	6	7
Very			Neutral			Very
Strongly						Strongly
Disagree						Agree

3. The information presented flowed smoothly.

1	2	3	4	5	6	7
Very			Neutral			Very
Strongly						Strongly
Disagree						Agree

4. The narration in the modules helped in understanding the material.

1	2	3	4	5	6	7
Very			Neutral			Very
Strongly						Strongly
Disagree						Agree

Presentation (Excerpt from Simulation Module Questionnaire)

5. It was easy to navigate through the screens.

1	2	3	4	5	6	7
Very			Neutral			Very
Strongly						Strongly
Disagree						Agree

Figure 5: Presentation Section from Simulation Module

Format (Excerpt from the Simulation Module Questionnaire)

1. The colors used on the screen did not distract from the task or cause eye discomfort.

1	2	3	4	5	6	7
Very			Neutral			Very
Strongly						Strongly
Disagree						Agree

2. The buttons on the screen were easy to understand.

1	2	3	4	5	6	7
Very			Neutral			Very
Strongly						Strongly
Agree						Disagree

3. The time for the computer to process information did not frustrate you.

1	2	3	4	5	6	7
Very			Neutral			Very
Strongly						Strongly
Disagree						Agree

4. You were satisfied with the interaction with the computer.

1	2	3	4	5	6	7
Very			Neutral			Very
Strongly						Strongly
Disagree						Agree

5. The tutorial was effective in providing instruction.

1	2	3	4	5	6	7
Very			Neutral			Very
Strongly						Strongly
Disagree						Agree

6. The picture quality used for the aircraft was realistic.

1	2	3	4	5	6	7
Very			Neutral			Very
Strongly						Strongly
Disagree						Agree

7. The picture quality of the defects was realistic.

1	2	3	4	5	6	7
Very			Neutral			Very
Strongly						Strongly
Disagree						Agree

Figure 6: Format Section from Simulation Module

Usability Dimension	Cronbach Alpha Coefficient	
	General Module	Simulation Module
Content	0.94	0.82
Presentation	0.82	0.63
Format	0.68	0.73

Table 1: Results from Cronbach Analysis

Usability Dimension	7 point rating scale 1 7		General Module Mean (S.D.)	Simulation Module Mean (S.D.)
Content	Very Strongly Disagree	Very Strongly Agree	5.15 (1.5)	4.7 (1.4)
Presentation	Very Strongly Disagree	Very Strongly Agree	5.4 (0.98)	5.1 (1.4)
Format	Very Strongly Disagree	Very Strongly Agree	5.2 (1.2)	5.0 (1.5)

Table 2: Results from the Usability Questionnaire

Issue Addressed	Wilcoxon Result	Indications
Content	$p < 0.05$	$\mu = 4$ (Significantly)
Presentation	$p < 0.05$	$\mu = 4$ (Significantly)
Format	$p < 0.05$	$\mu = 4$ (Significantly)

Table 3: Results from Wilcoxon Signed Rank Test

Recommendations

Control studies are currently underway which will evaluate the usefulness of the ASSIST Program in improving inspection performance. Initial results of these studies have been encouraging. It is anticipated that the use of ASSIST will standardize inspection training leading to improved inspection performance, ultimately yielding improved aircraft safety and reliability.

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